PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 19 October 2000 (19.10.00)	
International application No. PCT/GB00/00721	**Applicant's or agent's file reference** SMC/LF/P4258
International filing date (day/month/year) 03 March 2000 (03.03.00)	**Priority date** (day/month/year) 05 March 1999 (05.03.99)
Applicant O'HARA, Kenneth	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

22 September 2000 (22.09.00)

[] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Olivia TEFY
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38



PATENT COOPERATION TREATY

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INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
SMC/LF/P4258		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB 00/ 00721	03/03/2000	05/03/1999
Applicant		
O'HARA, Kenneth		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

 a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

 [] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

 b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

 [] contained in the international application in written form.

 [] filed together with the international application in computer readable form.

 [] furnished subsequently to this Authority in written form.

 [] furnished subsequently to this Authority in computer readble form.

 [] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

 [] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [] **Certain claims were found unsearchable** (See Box I).

3. [] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

 [X] the text is approved as submitted by the applicant.

 [] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

 [X] the text is approved as submitted by the applicant.

 [] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

 [] as suggested by the applicant.

 [X] because the applicant failed to suggest a figure.

 [] because this figure better characterizes the invention.

 [] None of the figures.

PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
SMC/LF/P4258		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/00721	03/03/2000	05/03/1999
International Patent Classification (IPC) or national classification and IPC C02F3/20		
Applicant O'HARA, Kenneth		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

 ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

 These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:

 - I ☒ Basis of the report
 - II ☐ Priority
 - III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
 - IV ☐ Lack of unity of invention
 - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
 - VI ☐ Certain documents cited
 - VII ☐ Certain defects in the international application
 - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
22/09/2000	15.06.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Grigoraki, E Telephone No. +49 89 2399 8353

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/00721

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1-8	as originally filed				

Claims, No.:

1-20	as received on	09/03/2001	with letter of	28/02/2001

Drawings, sheets:

1/1	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

 These elements were available or furnished to this Authority in the following language: , which is:

 ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
 ☐ the language of publication of the international application (under Rule 48.3(b)).
 ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

 ☐ contained in the international application in written form.
 ☐ filed together with the international application in computer readable form.
 ☐ furnished subsequently to this Authority in written form.
 ☐ furnished subsequently to this Authority in computer readable form.
 ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
 ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

 ☐ the description, pages:
 ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

 (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

 ☐ the entire international application.

 ☒ claims Nos. 19,20.

because:

 ☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):

 ☒ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):
 see separate sheet

 ☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

 ☐ no international search report has been established for the said claims Nos. .

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

 ☐ the written form has not been furnished or does not comply with the standard.

 ☐ the computer readable form has not been furnished or does not comply with the standard.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

 Novelty (N) Yes: Claims 1-18

	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-18
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-18
	No:	Claims	

2. Citations and explanations
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Conc. Section III:

Claims 19 and 20 do not define clearly the subject matter for which protection is sought and are thus objectionable under article 6 PCT; they moreover allow several embodiments to be interpreted therein so that no meaningful opinion as to novelty and inventive step can be formed.

Conc. Section V:

Reference is made to the following documents:
D1: GB-A-2 326 603
D2: US-A-3 651 646

D1 or D2 are considered to be the closest prior art and disclose air diffuser systems with a distribution supply line and a plurality of outlet lines branching therefrom.
The valves used in the outlet lines in D1 are designed to give a precise flow by using a predetermined size of the slots/holes. The check valve in D2 utilises a nozzle plate with an opening of predetermined diameter to control the volume of air being emitted by the nozzle.

D1 or D2 do not appear to disclose a constant flow regulator in each outlet line. D1 or D2 do not render obvious the feature of regulating the flow to a constant (set) amount over a range of pressures i.e when the pressure in the pipe system exceeds a predetermined minimum value.

The object underlying the claimed method and the system was to provide a very simple means of delivering uniform quantities of air from a pipeline involving several outlets. With the proposed constant flow regulator it is possible to run a pipe eg along the length of an undulating river bed and achieve the same flow at each outlet. Such a measure is not rendered obvious from the other cited prior art in combination.

The subject matter of claims 1(method) and 8 (system) as well as of the dependent thereon claims 2-7 and 9-18 is therefore novel and inventive as required by articles 33(2) and (3) PCT.

Conc. Section VIII:

In claims 6 and 7 which are dependent on claim 1 (method) the word "system" should read "method". Otherwise these claims with present wording are objectionable under article 6 PCT.

CLAIMS

1. A method of mixing, aerating or oxygenating ponds, rivers or lakes, sewage/treatment lagoons or effluent beds or air striping volatile compounds from water or other solutes, the method comprising distributing air or oxygen through a piped system having a plurality of outlet lines branching from a common supply line or manifold, by continuously generating a predetermined minimum volume of air or oxygen and introducing it into the pipe system, delivering a desired quantity of the air or oxygen at each of the outlets by providing a constant flow regulator means in each outlet line which limits the flow to a set amount when the pressure in the pipe system exceeds a predetermined minimum value.

2. A method as claimed in claim 1 in which the minimum volume of air or oxygen exceeds a calculated minimum volume which is required to be delivered from the outlets.

3. A method as claimed in claims 1 or 2 in which substantially the same quantity of air or oxygen is delivered at each outlet irrespective of pressure drop along the pipe, at least within a flow range which is deemed acceptable.

4. A method as claimed in anyone of claims 1 to 3 in which a moving element constant flow regulator is used.

5. A method as claimed in claim 1 in which the pressure is kept substantially constant along the distribution line and an accurate and even quantity of air or oxygen is delivered at each outlet using a moving "O" ring constant flow regulator which operates at its set maximum flow rate to deliver the desired flow at the set pressure.

6. A system as claimed in claim 1 in which a predetermined minimum volume of air or oxygen is supplied, which volume is calculated to exceed the minimum volume which is to be delivered from all the outlets from the outlet lines.

7. A system as claimed in claim 1 in which the desired flow of air or oxygen is a desired even flow of air or oxygen.

8. A mixing, aeration or oxygenation system to aerate or oxygenate ponds, rivers, or lakes, sewage or effluent treatment lagoons or beds or to airstrip volatile compounds from water or other solutes and comprising an air or oxygen distribution supply line, a source of air or oxygen pressure connected to the distribution supply line, and a plurality of outlet lines branching from the distribution supply line, and characterised by a constant flow regulator disposed in each outlet line to cause a desired flow of air or oxygen to be delivered through the outlet lines.

9. A system as claimed in claim 8 in which the regulator is tuned to deliver the desired calculated supply of air or oxygen required at the outlet line irrespective of changes in supply pressure such that it is self compensating for changes in supply pressure within its designed operating range.

10. A system as claimed in claim 8 in which the regulator is designed to only allow a desired maximum flow (volume) of air or oxygen to pass through at a known pressure of air or oxygen.

11. A system as claimed in claim 10 in which the constant flow regulator comprises an "O" ring moving element ring constant flow regulator.

12. A system as claimed in anyone of claims 8 to 11 in which each outlet line has a suitable outlet nozzle.

13. A system as claimed in claims 8 to 12 in which the outlet lines are disposed in series along the distribution line.

14. A system as claimed in anyone of claims 8 to 13 in which the source of air or oxygen pressure is a pump which delivers a constant volume of air or oxygen.

15. A system as claimed in anyone of claims 8 to 14 in which the distribution supply line comprises at least one length of pipe.

16. A system as claimed in anyone of claims 8 to 15 in which the distribution supply line comprises a plurality of lengths of pipe branching from a common manifold or having a direct connection with the supply of air or oxygen.

17. A system as claimed in anyone of claims 8 to 16 in which the pipeline includes a return line or is of ring main type.

18. A system as claimed in anyone of claims 8 to 17 in which the outlet lines incorporate a backflow regulation device and/or an isolation ball valve.

19. A method of aerating or oxygenating ponds, rivers or lakes, sewage/treatment lagoons or effluent beds or air striping volatile compounds from water or other solutes, by distributing air or oxygen through a piped system when constructed and arranged substantially as hereinbefore described with reference to the accompanying drawings.

20. A mixing, aeration or oxygenation system to aerate or oxygenate ponds, rivers, or lakes, sewage or effluent treatment lagoons or beds or to airstrip volatile compounds from water or other solutes constructed and arranged substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 00/00721

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C02F3/20 C02F7/00 B01F3/04 G05D7/01

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C02F G05D B01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	GB 2 326 603 A (RED VALVE CO INC) 30 December 1998 (1998-12-30) abstract; figures 1,9	6-8, 12-20 1-3,9
X A	US 3 651 646 A (GRUNAU HEINZ) 28 March 1972 (1972-03-28) the whole document	6-8, 12-15, 18-20 1-3
A	US 4 960 546 A (THARP CHARLES E) 2 October 1990 (1990-10-02) the whole document	1-3,6-8, 12-20
A	US 3 293 861 A (HINDE J N) 27 December 1966 (1966-12-27) column 4, line 12-33; figures 1-3,11	1-3,6-8, 12-20

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 May 2000	15/06/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Gruber, M

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 847 178 A (KEPPEL W) 12 November 1974 (1974-11-12) the whole document	4,5,9-11
A	US 5 184 641 A (KUHN DIETER) 9 February 1993 (1993-02-09) the whole document	4,5,9-11

INTERNATIONAL SEARCH REPORT

...formation on patent family members

...nal Application No
PCT/GB 00/00721

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2326603 A	30-12-1998	NONE	
US 3651646 A	28-03-1972	NONE	
US 4960546 A	02-10-1990	NONE	
US 3293861 A	27-12-1966	NONE	
US 3847178 A	12-11-1974	DE 2131117 A	11-01-1973
		CA 956204 A	15-10-1974
		DE 2060751 A	29-06-1972
		DK 146699 B	05-12-1983
		ES 397792 A	16-05-1974
		FI 54982 B	29-12-1978
		FR 2117611 A	21-07-1972
		GB 1601375 A	28-10-1981
		GB 1350846 A	24-04-1974
		IT 941391 B	01-03-1973
		JP 51023059 B	14-07-1976
		SE 397736 B	14-11-1977
		SU 416972 A	25-02-1974
		JP 51023060 B	14-07-1976
US 5184641 A	09-02-1993	DE 4029183 A	19-03-1992
		AT 107383 T	15-07-1994
		DE 59101930 D	21-07-1994
		EP 0475097 A	18-03-1992
		ES 2055495 T	16-08-1994

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 :
C02F 3/20, 7/00, B01F 3/04, G05D 7/01

A1

(11) International Publication Number: WO 00/53534

(43) International Publication Date: 14 September 2000 (14.09.00)

(21) International Application Number: PCT/GB00/00721

(22) International Filing Date: 3 March 2000 (03.03.00)

(30) Priority Data:
9904946.2 5 March 1999 (05.03.99) GB

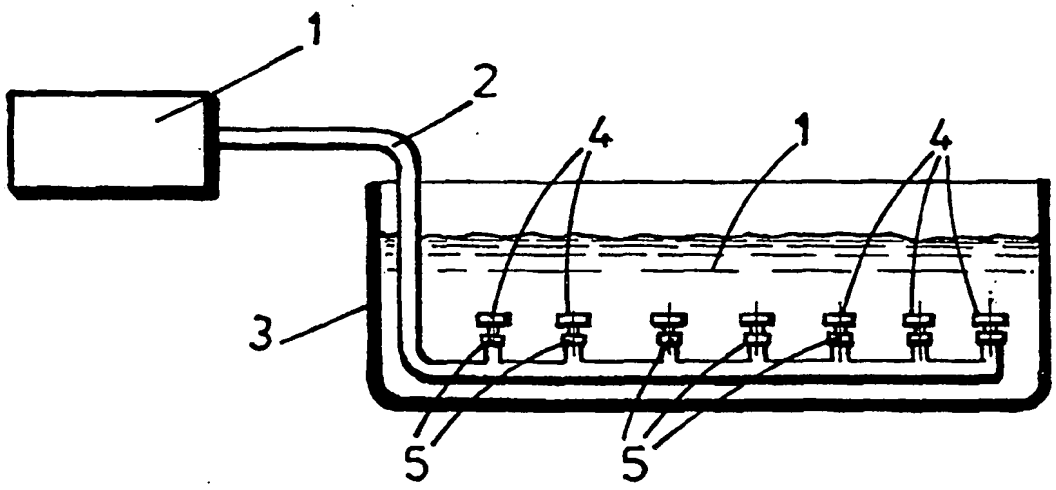
(71)(72) Applicant and Inventor: O'HARA, Kenneth [GB/GB]; Pen-yr-allt Farm House, Lake Road, Padeswood, Mold, Flintshire CH7 4H7 (GB).

(74) Agent: ROYSTONS; Tower Building, Water Street, Liverpool L3 1BA (GB).

(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: MIXING, AERATION OR OXYGENATING METHOD AND APPARATUS



(57) Abstract

A mixing, aerating or oxygenating method and apparatus to aerate or oxygenate ponds, rivers, or lakes, sewage or effluent treatment lagoons or beds or to airstrip volatile compounds from water or other solutes by distributing gas through a piped system having a plurality of outlet lines (4) branching from a common supply line (2). In order to deliver a desired quantity of air or oxygen at each outlet, a constant flow regulator (5) is disposed in each outlet line which limits the flow to a set amount when the pressure in the pipe system exceeds a predetermined minimum value. In one method the regulator is chosen to achieve this irrespective of pressure drop along the pipe. In another method the regulator is chosen to give the desired output with no pressure drop along the pipe.

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Title: Mixing, Aeration or Oxygenating Method and Apparatus

The present invention relates to a method and apparatus for regulating the distribution of gaseous fluids and in particular to a mixing, aerating or oxygenating method and apparatus to aerate or oxygenate ponds, rivers, estuaries, reservoirs or lakes, sewage or effluent treatment lagoons beds or tanks or to airstrip volatile compounds from water or other solutes.

There are many situations where submerged diffusers are used to introduce gas into a liquid. For example to transfer oxygen into a liquid (typically water) for the purposes of aeration and mixing, and especially to oxygenate the water. Such techniques are used in aerobic biological treatments systems as used to treat sewage, effluents of various types, and storm water and water in aquaria or lakes and rivers, among others. They are also used for air stripping of volatile organics from contaminated water.

It is common to treat sewage in "activated sludge treatment plants" by feeding precise volumes of air to a plurality of diffusers which release the air into the water in precise small bubbles to stimulate natural processes. The number of diffusers and hence the spacing is calculated relative to the volume of water to be treated and the amount of treatment required. The diffusers are usually placed at the lowest point in the water column allowing the most time for air to pass through the water prior to reaching the atmosphere.

In the known systems a plurality of diffusers are fed from a supply line, usually from a suitable air source such as an air pump, which delivers a constant and even supply of air. The diffusers are disposed in series along the supply line and the quantity of air emerging from each diffuser is intended to be substantially the same. In the known sewage treatment systems potential pressure drop along the line from one diffuser to the

next is rendered negligible by utilising a supply pipe having a large cross-sectional area and a relatively low-pressure supply. The cross-section of the pipe has to be calculated having regard to the number of diffusers and the discharge rate in order to ensure that there is a negligible pressure drop along the length of the pipe and thereby ensure that the flow from the diffusers is balanced. In other specific aeration systems a manually adjustable valve or oriface control may be provided for each diffuser to balance their output. The known system of individually balanced gas diffusers is difficult to set up to ensure correct balance, usually requiring accurate levelling of the outlet diffusers.

A constant flow regulator and a method of manufacturing same comprising a moving "O" ring is described in Patent Nos. EP 115342 and GB 2136713. The described regulator gives a constant through volume flow rate of liquid over a wide range of supply pressures. A regulator of this type can be designed to produce a specific flow rate over a prescribed pressure range and can be moulded from plastics which makes them extremely economical to produce. When a plurality of such constant flow devices are fitted in series in a pipeline supplied with liquid at a sufficiently high pressure, the flow rate is constant from each regulated line irrespective of the pressure fluctuations along the pipeline(s) of the system. The supply line pressure has to be above a pre-determined minimum level at the point where the pressure drop is highest. Usually this will be at the end of the pipeline. The use of these devices has not been considered to regulate the flow of air or oxygen. There is no teaching to use these devices with fluids other than liquids. The reason for this may be that none of the commercially available devices have been deemed able to operate to produce constant flow with fluctuating air pressure.

It is an aim of the present invention to provide a gas distribution system which overcomes the current difficulties.

One aspect of the invention provides a method of distributing gas through a piped system having a plurality of outlet lines branching from a common supply line or manifold, the method comprising continuously generating a predetermined minimum volume of gas and introducing it into the pipe system, delivering a desired quantity of gas at each of the outlets by providing a constant flow regulator means in each outlet line which limits the flow to a set amount when the pressure in the pipe system exceeds a predetermined minimum value.

More particularly, the present invention provides a method of mixing, aerating or oxygenating ponds, rivers or lakes, sewage/treatment lagoons or effluent beds or air striping volatile compounds from water or other solutes, the method comprising distributing air or oxygen through a piped system having a plurality of outlet lines branching from a common supply line or manifold, by continuously generating a predetermined minimum volume of air or oxygen and introducing it into the pipe system, delivering a desired quantity of the air or oxygen at each of the outlets by providing a constant flow regulator means in each outlet line which limits the flow to a set amount when the pressure in the pipe system exceeds a predetermined minimum value.

For the aforementioned applications the gas as referred to hereinafter will be air or oxygen.

More particularly the predetermined minimum volume of gas exceeds a calculated minimum volume which is required to be delivered by the diffusers. Preferably a moving element control flow regulator is chosen to achieve this irrespective of pressure drop along the pipe, at least within a pressure range which is deemed acceptable. For most applications an accurate and even quantity of gas is delivered at each outlet. This can be achieved using constant flow regulators having a specific and even flow rating for each outlet.

Another aspect of the present invention provides a gas distribution system comprising a gas distribution supply line, a source of gas pressure connected to the distribution supply line, and a plurality of outlet lines branching from the distribution supply line, and characterised by a constant flow regulator disposed between the distribution supply line and each outlet line to cause a desired flow of gas to be delivered through the outlet lines.

More particularly, the present invention provides a mixing, aeration or oxygenation system to aerate or oxygenate ponds, rivers, estuaries, reservoirs or lakes, sewage or effluent treatment lagoons or beds or to airstrip volatile compounds from water or other solutes and comprising an air or oxygen distribution supply line, a source of air or oxygen pressure connected to the distribution supply line, and a plurality of outlet lines branching from the distribution supply line, and characterised by a constant flow regulator disposed in each outlet line to cause a desired flow of air or oxygen to be delivered through the outlet lines.

For the aforementioned application the gas referred to herewith will be air or oxygen. There may be more than one distribution line.

More particularly a predetermined minimum volume of gas is supplied, which volume is calculated to exceed the minimum volume which is to be delivered from the diffusers. The desired flow of gas is a desired even flow of gas.

The constant flow regulator may be a moving "O" ring constant flow regulator or other moving element constant flow regulator which is precisely tuned to deliver the desired calculated supply of gas required at the outlet line irrespective of changes in supply pressure such that it is self compensating for changes in supply pressure within its designed operating range.

In an alternative, a moving "O" ring regulator is used that only allows a desired maximum flow (volume) of gas to pass through above a known pressure of gas. Using such a regulator, pressure drops along the pipeline can be compensated for by using a regulator which has the desired maximum flow at a lower pressure to reflect the pressure drop. By this means a substantially even flow of gas is achieved from all the outlets. It will be understood that when the term even is used, there will most usually be an acceptable tolerance variation to the desired flow rate.

Each outlet line has a suitable outlet nozzle. They may be aeration nozzles, diffusers or any other suitable nozzle for the intended application. In a preferred application each outlet line supplies a respective diffuser. Conveniently the outlet lines are disposed in series along the distribution supply line. The number of outlet lines and hence outlet nozzles/diffusers are calculated and spaced according to the particular application. Preferably the gas originates from a suitable source, usually generated by a pump gas blower or generator or other suitable device, and preferably it delivers a constant volume of gas. The system can be used for distributing any desired gas composition. For many applications the gas will be air other gases could be oxygen, carbon dioxide, nitrogen or ozone. The distribution supply line comprises at least one length of pipe. As an alternative it may comprise a plurality of lengths of pipe branching from a common manifold or having a direct connection with the supply of gas. The pipeline may include a return line or be of ring main type. The outlet lines may incorporate a backflow regulation device and/or an isolation ball valve. Such devices may incorporate the aforesaid constant flow regulator or be provided as separate devices. The constant flow regulator, any backflow regulation device and any isolation valve may be combined with an outlet diffuser.

The invention can be used for a large number of potential applications, for example the treatment sewage, leachate and agricultural waste water by the introduction of air, air stripping of volatile compounds from water or other solutes, mixing water columns, aerating and mixing of aquaria, ponds, lakes and rivers or tanks containing fish, and in connection with various industrial processes. Where the system is used for the purpose of introducing gas into a liquid or other gas, the backflow prevention device avoids the liquid or gas entering the system should the system enter a state of relative negative pressure. The isolation ball valve allows individual branches to be isolated. The system can be used to control a bubble curtain.

For any given application the delivery rate from the outlet lines will be known and the source of gas will be capable of maintaining a constant supply of no less than the calculated minimum requirement for the system.

The present invention may be used for any of the above mentioned applications and any other applications in which gas, and in particular air or oxygen is to be transferred to a liquid.

The present invention will now be described further hereinafter, by way of example only, with reference to the accompanying drawings; in which: -

Figure 1 shows schematically one embodiment of air distribution system embodying the present invention, and

Figure 2 is a graph of flow rate against pressure for a preferred pressure regulator.

For convenience the present invention is described by way of example in relation to the treatment of water by the injection of air. In one application for waste treatment the water will contain effluent. The water/effluent to be treated is shown at 1 and held within an open well or receiver 3. An air distribution pipeline 2 extends from a source of air 1 which supplies the air under pressure to the pipeline. A motor driven pump (not

illustrated) conveniently serves this purpose. The pipeline 2 has a plurality of outlets 4 disposed along the length thereof at spaced intervals. For the purpose of effluent treatment each outlet is provided with a diffuser which releases the air into the water/effluent in the form of small bubbles. In order to ensure that the flow of air from each diffuser is the same, a regulator 5 is incorporated into the flow line between the pipework 2 and the outlet diffuser 4. The regulator may be part of the diffuser or a separate component. The regulator is designed to deliver a constant flow irrespective of pressure variations in the pipeline when the pressure in the pipeline exceeds a predetermined minimum value, which minimum value is calculated to be that which will ensure that each regulator supplies the desired volume of gas. The preferred regulator device is of a type known as a moving element constant flow regulator such as described in the above mentioned patents. These are very economical to produce, especially when moulded from plastics.

The preferred moving element regulator is designed to operate to deliver a desired flow of air over a range of supply pressures. That is to say it is self-compensating for changes in supply pressure over a prescribed range of pressures above a minimum pressure level. Figure 2 is a graph of a constant pressure regulator of moving element type having characteristics of the described type and shows flow volume against pressure. It shows how the flow rate plateaus after pressure P1. Using a plurality of flow regulators in a distribution supply line will give rise to an even delivery of air from the plurality of diffusers providing the pressure in the pipeline exceeds the minimum threshold value P1.

In an alternative, using an "O" ring type regulator, the regulator only allows a set maximum flow (volume) of air to pass through at a given pressure of air providing the pressure in the system does not exceed that given pressure, then the flow rate from each outlet line will be at the set maximum flow rate, and a regulator is chosen which provides

the desired flow rate for a particular application. This can be used where there is little or no pressure drop along the distribution line.

CLAIMS

1. A method of mixing, aerating or oxygenating ponds, rivers or lakes, sewage/treatment lagoons or effluent beds or air striping volatile compounds from water or other solutes, the method comprising distributing air or oxygen through a piped system having a plurality of outlet lines (4) branching from a common supply line or manifold (2), characterised by continuously generating a predetermined minimum volume of air or oxygen and introducing it into the pipe system, delivering a desired quantity of the air or oxygen at each of the outlets by providing a constant flow regulator means (5) in each outlet line which limits the flow to a set amount when the pressure in the pipe system exceeds a predetermined minimum value.
2. A method as claimed in claim 1 in which the minimum volume of air or oxygen exceeds a calculated minimum volume which is required to be delivered from the outlets.
3. A method as claimed in claims 1 or 2 in which substantially the same quantity of air or oxygen is delivered at each outlet irrespective of pressure drop along the pipe, at least within a flow range which is deemed acceptable.
4. A method as claimed in anyone of claims 1 to 3 in which a moving element constant flow regulator is used.
5. A method as claimed in claim 1 in which the pressure is kept substantially constant along the distribution line and an accurate and even quantity of air or oxygen is delivered at each outlet using a moving "O" ring constant flow regulator which operates at its set maximum flow rate at the set pressure.
6. A mixing, aeration or oxygenation system to aerate or oxygenate ponds, rivers, or lakes, sewage or effluent treatment lagoons or beds or to airstrip volatile compounds from water or other solutes and comprising an air or oxygen distribution supply line

(2), a source of air or oxygen pressure connected to the distribution supply line, and a plurality of outlet lines (4) branching from the distribution supply line, and characterised by a constant flow regulator (5) disposed in each outlet line to cause a desired flow of air or oxygen to be delivered through the outlet lines.

7. A system as claimed in claim 6 in which a predetermined minimum volume of air or oxygen is supplied, which volume is calculated to exceed the minimum volume which is to be delivered from all the outlets from the outlet lines.

8. A system as claimed in claims 6 or 7 in which the desired flow of air or oxygen is a desired even flow of air or oxygen.

9. A system as claimed in anyone of claims 6 to 8 in which the regulator is tuned to deliver the desired calculated supply of air or oxygen required at the outlet line irrespective of changes in supply pressure such that it is self compensating for changes in supply pressure within its designed operating range.

10. A system as claimed in anyone of claims 6 to 8 in which the regulator is designed to only allow a desired maximum flow (volume) of air or oxygen to pass through at a known pressure of air or oxygen.

11. A system as claimed in claim 10 in which the constant flow regulator comprises an "O" ring moving element ring constant flow regulator.

12. A system as claimed in anyone of claims 6 to 11 in which each outlet line has a suitable outlet nozzle.

13. A system as claimed in claims 6 to 12 in which the outlet lines are disposed in series along the distribution line.

14. A system as claimed in anyone of claims 6 to 13 in which the source of air or oxygen pressure is a pump which delivers a constant volume of air or oxygen.

15. A system as claimed in anyone of claims 6 to 14 in which the distribution supply line comprises at least one length of pipe.

16. A system as claimed in anyone of claims 6 to 15 in which the distribution supply line comprises a plurality of lengths of pipe branching from a common manifold or having a direct connection with the supply of air or oxygen.

17. A system as claimed in anyone of claims 6 to 16 in which the pipeline includes a return line or is of ring main type.

18. A system as claimed in anyone of claims 6 to 17 in which the outlet lines incorporate a backflow regulation device and/or an isolation ball valve.

19. A method of mixing, aerating or oxygenating ponds, rivers or lakes, sewage/treatment lagoons or effluent beds or air striping volatile compounds from water or other solutes, by distributing air or oxygen through a piped system when constructed and arranged substantially as hereinbefore described with reference to the accompanying drawings.

20. A mixing, aeration or oxygenation system to aerate or oxygenate ponds, rivers, or lakes, sewage or effluent treatment lagoons or beds or to airstrip volatile compounds from water or other solutes constructed and arranged substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

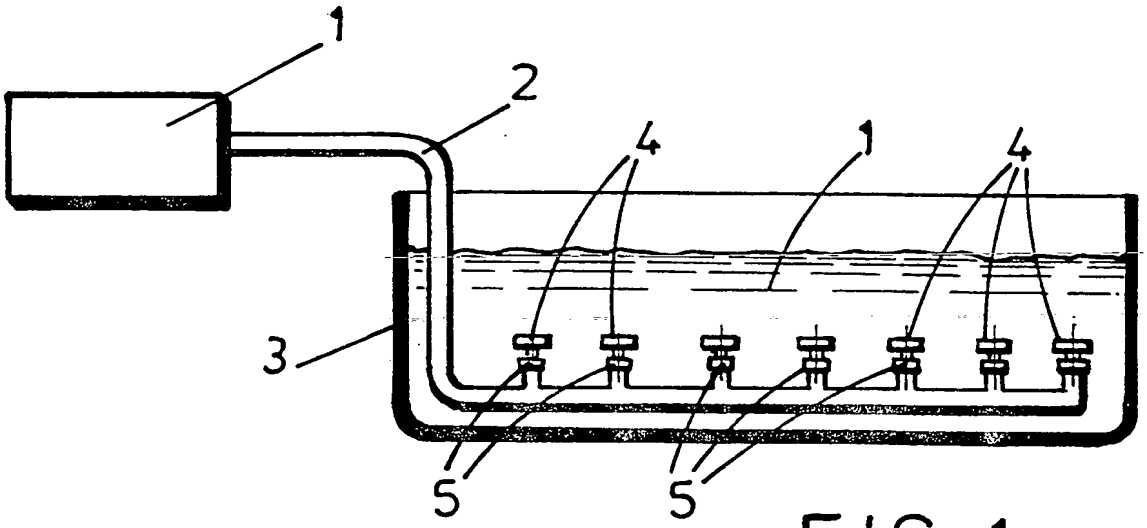


FIG. 1

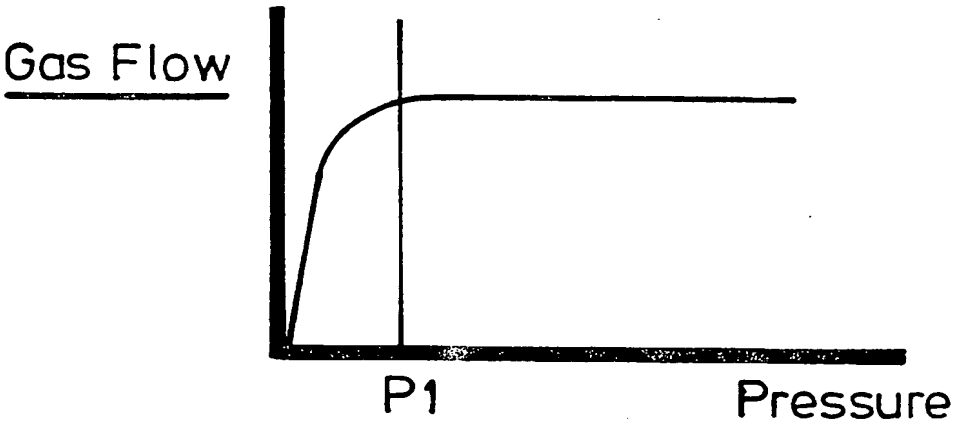


FIG. 2

INTERNATIONAL SEARCH REPORT

Inter. nal Application No
PCT/GB 00/00721

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C02F3/20 C02F7/00 B01F3/04 G05D7/01

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C02F G05D B01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	GB 2 326 603 A (RED VALVE CO INC) 30 December 1998 (1998-12-30) abstract; figures 1,9	6-8, 12-20 1-3,9
X A	US 3 651 646 A (GRUNAU HEINZ) 28 March 1972 (1972-03-28) the whole document	6-8, 12-15, 18-20 1-3
A	US 4 960 546 A (THARP CHARLES E) 2 October 1990 (1990-10-02) the whole document	1-3,6-8, 12-20
A	US 3 293 861 A (HINDE J N) 27 December 1966 (1966-12-27) column 4, line 12-33; figures 1-3,11	1-3,6-8, 12-20

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 May 2000	15/06/2000

Name and mailing address of the ISA	Authorized officer
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1

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INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/GB 00/00721

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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A	US 5 184 641 A (KUHN DIETER) 9 February 1993 (1993-02-09) the whole document	4,5,9-11

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

..formation on patent family members

Inter nal Application No
PCT/GB 00/00721

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		ES 2055495 T	16-08-1994

REPLACED BY ART 34 AMDT

CLAIMS

1. A method of mixing, aerating or oxygenating ponds, rivers or lakes, sewage/treatment lagoons or effluent beds or air striping volatile compounds from water or other solutes, the method comprising distributing air or oxygen through a piped system having a plurality of outlet lines (4) branching from a common supply line or manifold (2), characterised by continuously generating a predetermined minimum volume of air or oxygen and introducing it into the pipe system, delivering a desired quantity of the air or oxygen at each of the outlets by providing a constant flow regulator means (5) in each outlet line which limits the flow to a set amount when the pressure in the pipe system exceeds a predetermined minimum value.
2. A method as claimed in claim 1 in which the minimum volume of air or oxygen exceeds a calculated minimum volume which is required to be delivered from the outlets.
3. A method as claimed in claims 1 or 2 in which substantially the same quantity of air or oxygen is delivered at each outlet irrespective of pressure drop along the pipe, at least within a flow range which is deemed acceptable.
4. A method as claimed in anyone of claims 1 to 3 in which a moving element constant flow regulator is used.
5. A method as claimed in claim 1 in which the pressure is kept substantially constant along the distribution line and an accurate and even quantity of air or oxygen is delivered at each outlet using a moving "O" ring constant flow regulator which operates at its set maximum flow rate at the set pressure.
6. A mixing, aeration or oxygenation system to aerate or oxygenate ponds, rivers, or lakes, sewage or effluent treatment lagoons or beds or to airstrip volatile compounds from water or other solutes and comprising an air or oxygen distribution supply line

(2), a source of air or oxygen pressure connected to the distribution supply line, and a plurality of outlet lines (4) branching from the distribution supply line, and characterised by a constant flow regulator (5) disposed in each outlet line to cause a desired flow of air or oxygen to be delivered through the outlet lines.

7. A system as claimed in claim 6 in which a predetermined minimum volume of air or oxygen is supplied, which volume is calculated to exceed the minimum volume which is to be delivered from all the outlets from the outlet lines.

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20. A mixing, aeration or oxygenation system to aerate or oxygenate ponds, rivers, or lakes, sewage or effluent treatment lagoons or beds or to airstrip volatile compounds from water or other solutes constructed and arranged substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.